KANGA PRODUCTS

mØxpd©

Sudden Transmitter Shield

for the Arduino

Please Note*: T**his is not a complete transmitter system – you will need to provide RF signals to transmit and a low-pass filter appropriate to the band(s) on which you intend to transmit.***

Based on the "Sudden" transmitter, designed by Rev George Dobbs, G3RJV, it can be keyed manually, but is intended to be operated by a microcontroller and is, by virtue of the physical "shield" format, particularly useful in Arduino applications, such as the systems accompanying the "Occam's Microcontroller" article published by Paul, mØxpd, in SPRAT 156.

In addition to the PA and keying stages, there is a buffer / amplifier stage and a power supply stage, which are provided to integrate this module into a larger system (*perhaps including a DDS system and a receiver as well as the Arduino*). This buffer can be used with optional inputs on the board to support other applications and experiments beyond the beacons and CW transceivers currently available (such as DSB phone applications).

Important

There is a mismatch between the 2N7000 transistor package used in the PCB design and that of the devices supplied with the kit, which means Q7:Q9 must be inserted "back-to-front". See the section "Rx Muting" in the construction notes below.

Construction

Refer to the schematic and the parts list - This kit contains the parts required to build a QRP transmitter module for the lower HF bands, in “Arduino Shield” form-factor. Firstly identify all components against the list, if you find that a part is damaged or missing then please contact Kanga Products for a replacement.

In light of the similarity between some parts of this module and the Sudden transmitter on which it is based, you may find it useful to read the excellent notes accompanying the original Sudden Tx. These can be downloaded from the G-QRP website:

http://www.gqrp.com/Sudden_TX_Kit_manual_40m.pdf

Assembly is simplified if you follow a logical sequence which allows testing of completed sub-systems.

Power supply

The module includes a regulated power supply intended to produce a 5V supply for the remainder of a digital system from the (nominally 12V) supply used for the remainder of the transmitter module. Whilst the 5V supply does nothing on the present board, it is sensible to assemble it first, as it allows power to be conveniently applied to the board in testing and includes large components (such as the dc input socket and the 7805 regulator), which are best dealt with whilst the board is empty.

Fit the regulator, IC1, on its Heatsink. It is best to form the regulator’s legs (a 90 degree bend is required in the legs approximately 2.5mm from the plastic body of the package) and mount the regulator on the Heatsink (securing with a m3x6mm screw and nut) BEFORE soldering the legs. This will ensure correct positioning.

Fit the dc socket, CN1.

Fit capacitors C7, C8 and C11 (observing correct polarity of the latter two electrolytics).

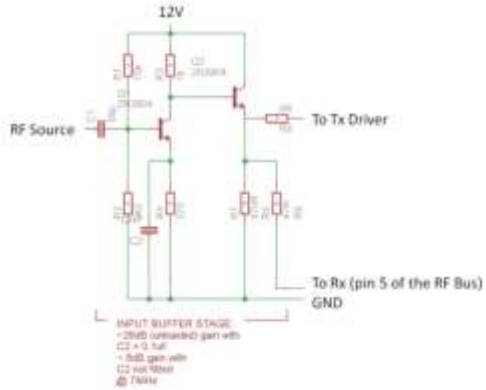
Fit the 2-pin header JP5 (this is used to connect the power supply to the Arduino’s 5V line, if required).

The power supply stage is complete – check that there is no short-circuit between the 12V input and ground or between the 5V rail and ground. Then apply 12V through the dc socket and confirm that 5V appears on JP5, pin 1.

Buffer / amplifier

RF signals are buffered and amplifier by the two-stage amplifier associated with Q1 & Q2. This has approximately 8dB of gain (which can be increased by fitting an optional capacitor, C2).

Fit resistors R1:R5 and R7. Fit a wire link (conveniently made from one of the legs you trimmed off another resistor) to make the 0 Ohm link R8.



Fit the 3-pin header JP1 (this will allow you to apply a test signal to the buffer stage).

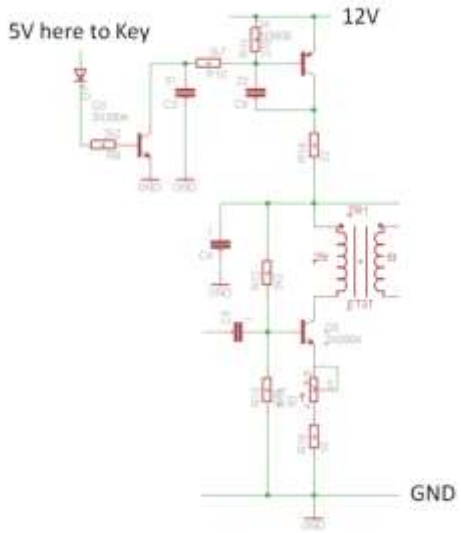
Fit C1, Q1 and Q2.

The buffer stage is now complete.

Apply (12V dc) power through the dc socket – the system should draw approximately 25mA. If you have means to check, apply a 7MHz test signal of approximately 500mV to JP1, pin2. The signal at the emitter of Q2 should be approximately 1.25V.

Driver and Keying Stages

The driver and keying stages are directly copied from the original Sudden transmitter – with the addition of the keying transistor Q3...



Fit diode D1 and D2 observing polarity. D2 is part of a later stage – but it is near the transformer and insertion is easiest at this point.

Fit resistor R6 and resistors R10:R17 (the last of which is not seen in the figure above).

Adjust the multi-turn preset R15 such that the resistance between the emitter of Q5 and ground is at maximum value (60 Ohms).

Fit capacitors C3, C5 and C6.

Fit transistors Q3:Q5, ensuring that you identify the correct types. Orientation is indicated by the silk-screening, which matches the package profile of the transistors.

The assembly to this point is illustrated below...

Now you must wind the transformer, TR1, on an FT-37 toroid.

It is convenient to use two colours of wire – for visual identification, also remember the secondary currents are higher than the primary in this transformer. The windings need not be perfect – an example is seen in the photo.

Wind the primary first (Copper coloured wire), this is 25 turns wound uniformly over about 80% of the circumference of the toroid. The secondary winding (Red coloured) needs only 5 turns and is wound over the primary.

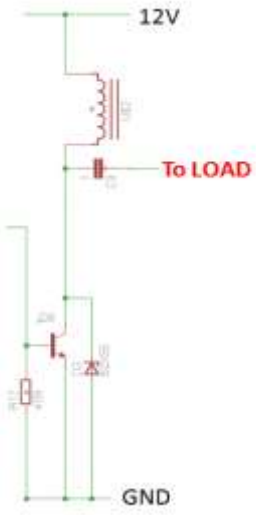
When both windings are complete, trim the wires to a length of around 10 mm measured from the edge of the toroid. To tin the end of the wires, form a bead of molten solder on the tip of the soldering iron and pass the end of the wire through it. After a few seconds the enamel will melt and the solder will wet the wire.

Add more solder until the wire is properly tinned. Avoid breathing in the fumes produced when soldering enamelled wire. Then fit into the board. The secondary winding goes into the two UPPER holes (in the orientation shown in the photo above).

The keying and driver stage is now complete.

Check your work again, for short circuits and solder splashes between the 12V input and ground. If you have means to check, apply a 7MHz test signal of approximately 500mV to JP1, pin2. Then "key" the system by connecting the anode of D1 to 5V (e.g. at JP5, pin 1). You should see the signal appearing across R17 (the transformer's secondary load) when the system is keyed.

PA Stage



Do not operate the transmitter unless the final stage is loaded by a correctly matched load – even in brief testing.

Fit the Zener diode D3, observing polarity.

Fit the antenna connector (right angled header) JP3

Fit the PA transistor, Q6. This should not be flush to the board – rather the package should sit up on its legs such that it stands approximately 5mm above the board. This will assist cooling but – ***most importantly*** – will give space to fit the Heatsink, which otherwise might foul on adjacent components.

> The Heatsink is a "spring" fit on the transistor casing – it is easily fitted or removed without straining the transistor legs by springing the Heatsink open slightly using needle-nose pliers (or a screwdriver – or circlip piers) whilst fitting.

The collector load L2 is shown on the PCB's silk-screen as a toroid but the required inductance is not practically achievable on a toroid in the available space. L2 is wound on a BN43-2402 binocular core. Using the second piece of Red coloured wire, make 5 complete turns, taking care not to damage the enamel insulation in the course of pulling through the holes. Following the same procedure as above for TR1, trim the wires to a length of around 10 mm measured from the edge of the toroid. To tin the end of the wires, form a bead of molten solder on the tip of the soldering iron and pass the end of the wire through it. After a few seconds the enamel will melt and the solder will wet the wire.

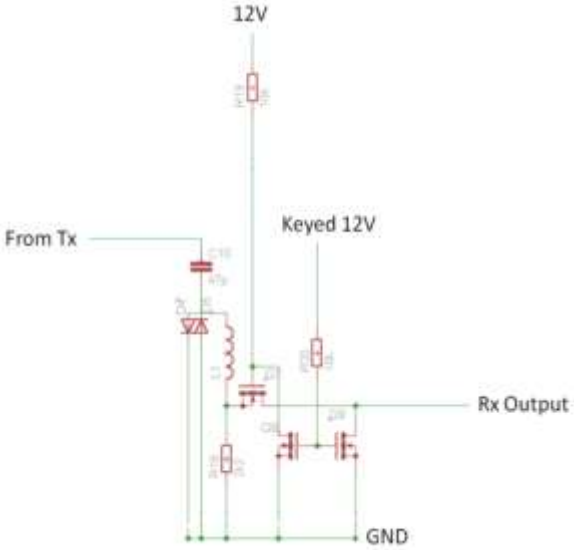
Add more solder until the wire is properly tinned. Avoid breathing in the fumes produced when soldering enamelled wire. Then fit into the board.

Testing can be performed at this stage – ensure that you load the transmitter appropriately, before applying power. You should also include an appropriate low-pass filter (no damage will result if you just use a 50 Ohm dummy load – but you won't see a clean signal).

An RF signal can be applied through JP1, pin 2. The system can be keyed by applying 5V (e.g. from JP5, pin 1) to the anode of D1, as with the red wire in the photo above. The system should be capable of delivering 1.5 W at 7MHz – adjust the drive control (R15) to secure appropriate output power and current consumption (a little under 0.6A).

Rx Mute

The original Sudden uses a series of MOSFETs to mute the signal passed to a receiver when the transmitter is keyed. This feature is not used in the "Occam's Microcontroller" rig (which uses AF Rx muting) but is implemented in the present kit.



If you do not intend to use the Rx mute, you can fit a jumper wire in place of Q7, joining what were to be Q7's source and drain.

Fit resistors R18:R20.

Fit diodes D4 & D5, observing polarity.

Fit inductor L1.

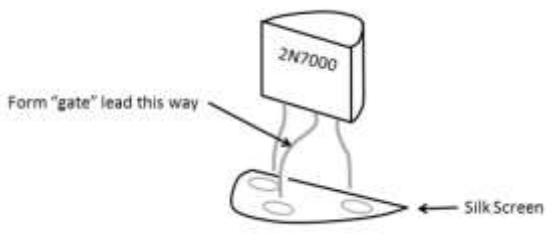
Fit Rx connector, JP4.

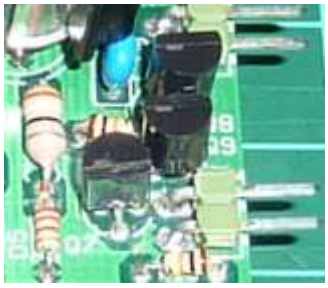
Fit transistors Q7:Q9

IMPORTANT:

There is a mis-match between the hole positioning and screen printing on the PCB and the pin-out of the transistors Q7:Q9 supplied with this kit. This means that these transistors must be inserted "back to front" relative to that positioning implied by the holes and the silk-screen, as suggested by the following sketch...

Correct orientation of the transistors is seen in the following photograph...





Final Assembly

Once the module is assembled and tested to this stage, the “stackable headers” that allow the board to “stack” on top of an Arduino may be fitted.

Take care to fit these normal to the board, so that they align with the Arduino’s sockets. The additional 6-way stackable header is for the “RF Bus” used on the other mØxpd shields.

In ordinary use, shorting jumpers are fitted between pins 2 & 3 of JP1 (this uses the “Sine 1” signal on the mØxpd RF bus, derived from a Kanga DDS shield, as input to the transmitter) and between pins 1 & 2 of JP5 (this passes the 5V supply on this module to other system components).

NOTES

Component Listing

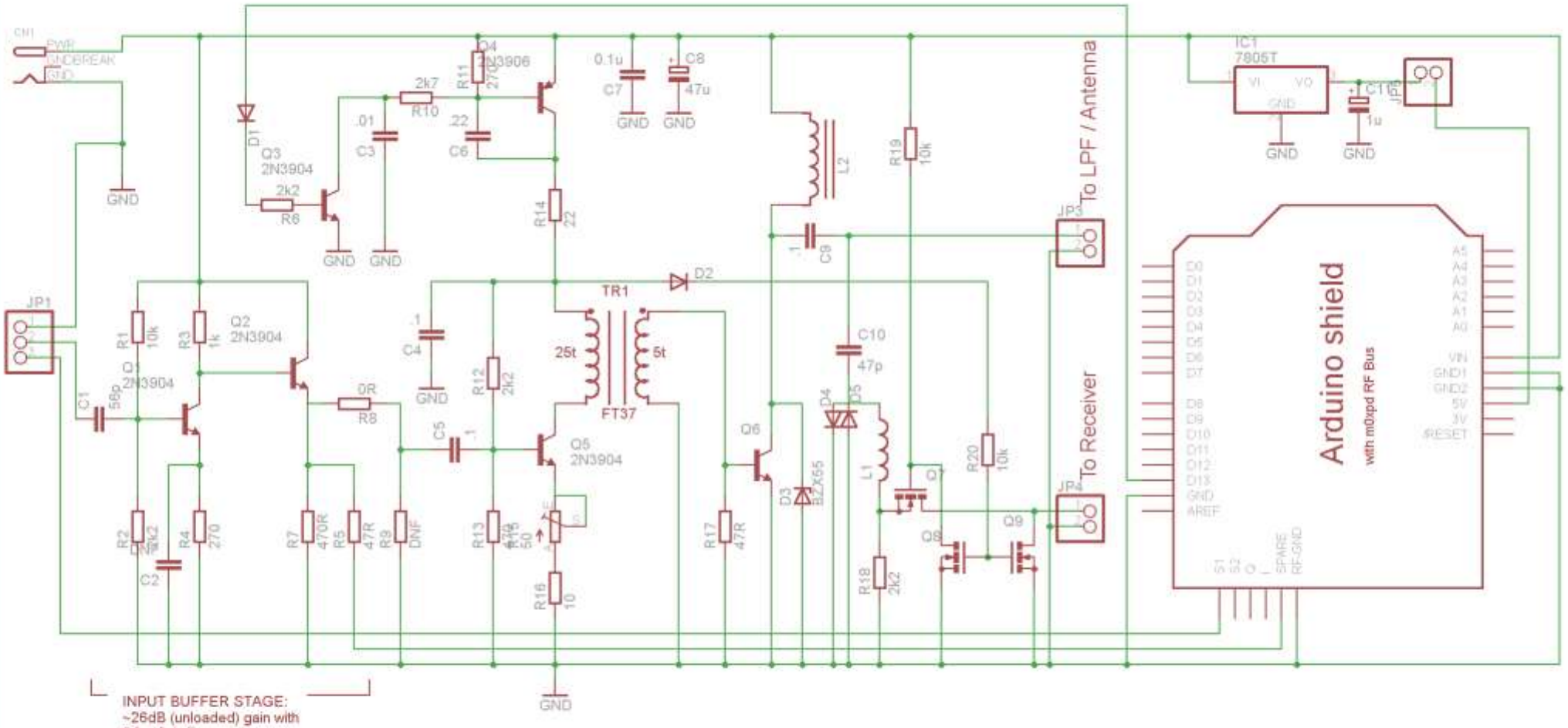
X	Part	Type	Marking	Notes
	R1	10KΩ	Brown, Black, Orange, Gold	
	R2	2K2Ω	Red, Red, Red, Gold	
	R3	1KΩ	Brown, Black, Red, Gold	
	R4	270Ω	Red, Black, Brown, Gold	
	R5	47Ω	Yellow, Purple, Black, Gold	
	R6	2K2Ω	Red, Red, Red, Gold	
	R7	470Ω	Yellow, Purple, Brown, Gold	
	R8	Wire link		See notes
	R9	Not used		Not required
	R10	2.7KΩ	Red, Purple, Red, Gold	
	R11	270Ω	Red, Purple, Brown, Gold	
	R12	2K2Ω	Red, Red, Red, Gold	
	R13	470Ω	Yellow, Purple, Brown, Gold	
	R14	22Ω	Red, Red, Black, Gold	
	R15	50Ω	50R	25 Multiturn Trimmer (Blue)
	R16	10Ω	Brown, Black, Black, Gold	
	R17	47Ω	Yellow, Purple, Black, Gold	
	R18	2.2KΩ	Red, Red, Red, Gold	
	R19	10KΩ	Brown, Black, Orange, Gold	
	R20	10KΩ	Brown, Black, Orange, Gold	
	C1	56pF	56	
	C2	Not used		Not required
	C3	10nF	103	
	C4	100nF	104	
	C5	100nF	104	
	C6	220pF	221	
	C7	100nF	104	
	C8	47µF	47µ 16v	Observe Polarity
	C9	100nf	104	
	C10	47pF	47	
	C11	1µF	1µF	Observe Polarity

Componet Listing Cont…..

X	Part	Type	Marking	Notes
	Q1	2N3904	2N3904	
	Q2	2N3904	2N3904	
	Q3	2N3904	2N3904	
	Q4	2N3906	2N3906	
	Q5	2N3904	2N3904	
	Q6	2N3866	2N3866	
	Q7	2N7000	2N7000	See Constructions Notes
	Q8	2N7000	2N7000	See Constructions Notes
	Q9	2N7000	2N7000	See Constructions Notes
	D1	1N4148	1N4148	Observe Polarity
	D2	1N4148	1N4148	Observe Polarity
	D3	BZX55C33	BZX55C33	Observe Polarity
	D4	1N5711	1N5711	Observe Polarity
	D5	1N5711	1N5711	Observe Polarity
	IC 1	LM7805	7805	Observe Polarity
	L1	10µH	Brown, Black, Black, silver	
	TR1	Black Toroid	x 1	Type 37-43
	L2	Binocular Toroid	x 1	Type BN43-2402
	Wire	Copper Colour	x 1	40cm
	Wire	Red Colour	x 2	20cm

Misc Parts

	Power Connector	x 1	
	Heatsink TO5	x 1	2N3866
	Heatsink TO-220	x 1	LM7805
	8 Pin Header (Arduino)	x 2	
	6 Pin Header (Arduino)	x3	
	90° Angle Header Pin	x2	
	3 Pin Header (Straight)	x 1	
	2 Pin Header (Straight)	x 1	
	Jumpers	x 2	
	Shield PCB		



INPUT BUFFER STAGE:
~26dB (unloaded) gain with
C2 = 0.1uF,
~ 8dB gain with
C2 not fitted
@ 7MHz

Choose R8 & R9 to attenuate signal from buffer stage as required

JP1: Fit jumper between pins 2 & 3
to run Tx from RF Bus VFO line

JP1: OR apply alternative input through
pin 2 (with ground at pin 1)

JP5: Fit jumper to power Arduino from this board

Arduino HF transmitter shield based on g3rjv's "Sudden" design m0xpd	
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